

- Savitz and Chen (1990) show significant increased risk of childhood cancer (Neuroblastoma (OR=11.8\*), Brain Tumour (OR=2.7\*) and CNS tumors (OR=1.7)) associated with parents who work in electrical and electronic industries.
- In 1985 an unusual number of children with leukaemia were identified living in the vicinity of broadcasting facilities (OR = 3.4: CI=0.70 -16.41), Maskarinec et al. (1993).
- United States physical therapists (Ouellet-Hellstrom and Stewart (1993)) show a 1.59-fold increase in miscarriage in the first 7 weeks of gestation when using microwave diathermy, and a dose-response relationship with increased treatments/month.
- Goldsmith (1995) reports an up-dated analysis of the US embassy in Moscow which does show a significant elevated risk of a wide range of cancers, including childhood leukaemia, after years of microwave irradiation, exposed to average levels of radar produced microwaves of 0.2 to 0.5  $\mu\text{W}/\text{cm}^2$ , peaking between 5 and 15  $\mu\text{W}/\text{cm}^2$  on the outside walls.
- Hocking and Gordon (1996) found a 2.74-fold increase in childhood leukaemia death within 4 km of TV and FM radio transmission masts in North Sydney between 1972 and 1990. Mean exposures were measured in the range 0.04 to 0.4  $\mu\text{W}/\text{cm}^2$ .
- Dolk et al. (1997a,b) found small but significant increases in adult leukaemia associated with FM and TV transmission towers in the United Kingdom.

In addition to the U.S. miscarriage study there are the Danish and Swedish physiotherapists studies, and many other studies are cited throughout this review. This shows why independent scientists continually find it disturbing and unprofessional when government and international reviews, such as that carried out for the WHO, Repacholi (1993) publish conclusions which are weak or even misleading, by stating that there is *"no clear evidence of detrimental effect"*. This is strongly at odds with the data presented.

Rather, in both the information set out in Repacholi (1993), and in additional studies which are available, clear indications of adverse health effects are associated with exposure to RF/MW in human populations, from impaired physical performance in situations of excessive exposure to microwaves, to adverse pregnancy and childhood outcomes from exposure during pregnancy to cancers from prolonged low level exposure.

When asked whether epidemiological evidence on the adverse health effects of RF/MW could be only described as a "weak link", Professor Goldsmith replied (p137, line 36)

**"I disagree. I think when children die of cancer between 5 and 18  $\mu\text{W}/\text{cm}^2$  over a period of time - exposure is not weak. It is significant."**

Here Professor Goldsmith is referring to the children of the staff of the U.S. Embassy in Moscow and other Eastern European embassies and the range of peak exposure levels on the outside walls of the United States Embassy in Moscow.

## **14. Classification of Carcinogens:**

### **14.1 Background:**

Many substances, originally assumed to be benign, are now classified as carcinogens. The classification as several levels or ranking from a possible human carcinogen to a proven human carcinogen. The vast majority of listed substances are potential carcinogens in various stages of investigation and weights of evidence of possible or probable carcinogenicity. Associate Professor Neil Pearce, epidemiologist at the Wellington Clinical school, says that about 19 of the 20 major human carcinogens were first identified by epidemiology, *pers comm*. Classification of human carcinogens must involve human epidemiological studies to receive a high classification. Animal studies give toxicological and biochemical evidence of processes which can give reinforcement to human epidemiological studies.

An epidemiological study which finds a statistically significant increase in cancer incidence in association with an identified risk factor may well be equivocal because of unknown confounding factors. The search to resolve this issue can involve further epidemiological studies and/or animal experiments when test animals are challenged with known levels of the possible carcinogen. If the results of a replicated animal experiment point strongly to the risk factor present and not discounted in the epidemiological studies then the risk factor would be classed as a Class C, possible human carcinogen.

Stronger animal data accompanied by stronger epidemiological evidence, moves the classification further up the scale.

### **14.2 A classification scheme:**

A recent comprehensive review by a team of Swedish researchers, Hardell et al (1995), applied criteria for evaluating groups of epidemiological studies to identify (a) no association, (b) probably no association, (c) possible association and (d) association. The US EPA use a class C to A classification. The following table illustrates the US EPA approach, which combines animal and epidemiological input:

Possible Carcinogen: Class C: The human evidence is inadequate but there is some "limited" animal experiments indicate increased cancer with increased exposure.

Probable Carcinogen: Class B2: Sufficient animal experiments with some, but not adequate human evidence.

Probable Carcinogen: Class B1: Sufficient animal experiments and limited human epidemiological evidence.

Human Carcinogen: Class A: Coherent, strong evidence of human epidemiology, backed up by strong animal evidence.

**Table 16: Potential Carcinogens**  
**EPA "Weight-of-Evidence" classification and Hazard Ranking**

Class A: Human Carcinogen	Class B: Probable Human Carcinogen B1: Limited Epidemiologic Evidence B2: Sufficient Animal Evidence	Class C: Possible Human Carcinogen
Arsenic (H)	Acrylonitrile (M)	Beryllium (M)
Asbestos (H)	Cadmium (M)	DDT (M)
Benzene (M)	Creosote (H)	PCBs (M)
Diethylstilbestrol (H)	Ethylene Oxide (M)	Carbon tetrachloride (M)
Vinyl chloride (H)	Ethylene oxide (M)	Dioxin (H)
	Formaldehyde (M)	
		Methyl Chloride (L)
		Trichloroethane (L)
		Saccharin (L)

Hazard Ranking: (H)=High; (M)=Medium; (L)=Low. Source Office of Health and Environmental Assessment, EPA June 1988

In relation to the RMA, where a "potential effect of low probability but high potential impact" gives a threshold for level of evidence based on epidemiological analysis. Through decisions of the Planning Tribunal the concept of "potential effect" incorporates a "plausible mechanism". This conforms to the EPA approach though the plausible mechanism does not necessarily use an animal model, but could equally be a biophysical/biochemical model. For ease of applying these criteria, they have been slightly modified by combining the epidemiological criteria from Hardell (1995) with the EPA approach.

1. **No association** based on: three or more studies showing no association with measured, estimated or evaluated EMF exposure or exposure hygienic classification. Confounding can be ruled out with reasonable confidence. Absence of animal or cell tissue experiments showing biological effects which could be potentially associated with cancer.
2. **Possible (Potential) carcinogen** (Class C) based on a "plausible mechanism and not mere innuendo", i.e. animal and cell tissue experiments reveal one or more plausible mechanisms by which the increased EMF exposure can reasonably lead to cancer initiating or cancer promoting cellular behaviour, or an replicated animal experiment showing responses consistent with cancer causing factors, such as impaired immune system, chromosome breakage, DNA damage, gene mutations, etc. A well performed animal experiment exists showing increased carcinomas but beyond this the animal evidence is "limited".
3. **Probable carcinogen** (Class B2) based on: three or more studies showing a pattern of an association with measured, estimated or evaluated EMR exposure or hygienic classification, backed up by plausible mechanisms through replicated animal and/or tissue experiments, as for Class C above.

4. **Highly Probable carcinogen** (Class B1) based on: consistent results in two or more well-performed studies showing excess risks and a dose-response in terms of measured, estimated or evaluated EMR exposure, or a consistent pattern of an association with excess risks in exposure hygienic classification. Confounding can be ruled out with reasonable confidence; backed up by plausible mechanisms through replicated animal or tissue experiments.
5. **Human carcinogen** (Class A) based on: consistent results in four or more well-performed studies showing excess risks and a dose-response in terms of measured, estimated or evaluated EMR exposure, or a consistent pattern of an association with excess risks in exposure hygienic classification. Confounding can be ruled out with strong confidence. Reliably demonstrated consistent causal mechanisms are available from more than one laboratory for each mechanism, through in vitro and/or in vivo experiments.

#### 14.3 Suppressed Official review - A case study:

While it may be true to claim that no official published reviews have accepted that EMR is potentially carcinogenic, it is definitely not true that no official high level authoritative reviews had recommended a carcinogenic classification.

In 1990 a team of 7 researchers from U.S. Government agencies, led by Dr Robert McGauchy, of the Human Health Assessment Group (HHAG), Office of Health and Environmental Assessment of the US EPA, produced a report for the EPA called ***"Evaluation of the Potential Carcinogenicity of Electromagnetic Fields"*** [EPA/600/6-90/005B]. The review team were asked by the Office of Radiation Programs to summarize and evaluate the available literature (to mid-1989) relating to the potential carcinogenicity of electromagnetic fields in the frequency range 3 Hz to 30 GHz. They reviewed human epidemiologic studies relating in some way to carcinogenesis, chronic animal studies, and short-term and in vitro studies related to carcinogenic effects of these fields. As of March 12, 1990 the review concluded the executive summary with:

**"Concerning the exposure to fields associated with 60 Hz electrical power distribution, the conclusion reached in this document is that such exposure is a 'probable' cancer risk factor, corresponding to a B1 degree of evidence that is a risk factor. This conclusion is based on a 'limited' evidence of carcinogenicity [in] humans which is supported by laboratory research indicating that the carcinogenic response observed in humans has a biological basis, although the precise mechanisms [are] only vaguely understood."**

**"For modulated non-thermal RF radiation, the human evidence is inadequate and the animal evidence is "limited" based on the finding of a field-induced increase in the incidence of carcinomas of all sites in rats in an experiment that produced minimal tissue heating. Therefore, the evidence of carcinogenicity for non-thermal modulated RF radiation dictates a classification as a "possible" or Class C carcinogen." (Microwave News M/J 1990)**

The report's recommendations were:

- a. That electromagnetic fields (ELFs) be classified as a "probable" human carcinogen.
- b. That radiofrequency and microwave radiation be classified as a "possible" human carcinogen.

Extremely strong pressure from the Bush White House and the U.S. Air Force led a senior EPA administrator, Dr William Farland, not a member of the review team nor the internal nor external peer review teams, to change the conclusions to state that the studies of electromagnetic fields and cancer among children and electrical workers:

**"show a consistent pattern of response, but does not prove a causal link."**

The Review team was not relying on proof of a causal link, which is not necessary for class B or C classification. A description of this process is given in Lancet, Sibbison (1990). Sibbison (1990) states that "Government officials in Washington tend to play down or even suppress news linking industrial pollutants to cancer. When I was a public relations man at the Environmental Protection Agency (EPA), their rationale, as explained to me, was always the same: 'we don't want to scare the public'.

A team of 22 other U.S. EPA scientists carried out an extensive review of the amended draft. This next draft was reviewed through a peer-review workshop held in Morrisville, North Carolina on June 28, 1990, involving 9 scientists who had not previously included in earlier reviews. This resulted in the October 1990 Review Draft which I have received. This has been prepared and reviewed by 38 scientists.

This group of 38 U.S. scientists, along with a greater number which can be identified through being authors of papers and reports which identify biological mechanisms and statistically significant epidemiological associations between EMR exposure and increased health risk, give the lie to the existence of a scientific consensus that there are no effects unless they are thermal.

Despite the extensive, deep and multiple reviews already carried out, the Review Draft still carried the Notice provided by a senior administrator in the EPA:

**"This document is a preliminary draft. It has not been formally released by EPA and should not at this stage be construed to represent Agency policy. It is being circulated for comments on its technical accuracy and policy implications."**

It is instructive to follow the history of the recommendations and reviews of this report.

Chapter 3 of the October 1990 External Review Draft, entitled "Epidemiologic studies of electromagnetic fields and cancer" commences with the following:

**"The epidemiologic literature for radiofrequency (RF) radiation was previously reviewed by the US EPA (1984) and by Elder (1987). But in the past few years, there has been a marked increase in epidemiologic studies reporting an association between cancer and electric and magnetic fields."**

**"Among eight studies of radiofrequency radiation in adults, five cohort studies have reported statistically significant risks of lymphatic and hematopoietic**

neoplasms, especially acute myeloid leukemia, in amateur radio operators based on proportional mortality ratios and standardized mortality ratios, and of cancers in Hawaii residents living in close proximity to RF towers based on standardized incidence ratios, and of hemotopoietic system cancer, including leukemia, lymphoma and lymphosarcoma, as well as melanoma from exposure to RF radiation, primarily from radar, in Polish military officers." (Dr Doreen Hill)

While acknowledging that misclassification of some non-exposed people as exposed was a strong possibility for dilution of the associated risk, and other methodological problems also exist for some studies. Dr Hill then concludes:

**"The studies of RF radiation in adults exposed to microwave radiation or radar, particularly ham radio operators, produced mixed results. Again the lack of definitive information about kind, level and strength of exposure, as well as confounders that may be responsible for the excess risks seen in the positive studies, precludes conclusions that a positive association exists with exposure to RF radiation."**

Hence, while some evidence of carcinogenicity existed but it was not consistent enough to conclude that there was a positive (probable) association and so the recommendation was for classification as a "possible" human carcinogen.

By 13/12/90 the covering letter, over the signature of Erich Bretthauer, Assistant Administrator for Research and Development, EPA, says:

**"While there are epidemiological studies that indicate an association between EM fields or their surrogates and certain types of cancer, other epidemiological studies do not substantiate this association. There are insufficient data to determine whether or not a cause and effect relationship exists. The document clearly reveals the need for further research."**

This reveals an important change in language and a different assessment of the epidemiological studies than the one concluded by the original research team and the first review. To the lay reader the use of the term "cause and effect relationship" might be misleading, in a subtle but important way. The level of proof has risen to the high level of scientific evidence which proves cause and effect. The statement then correctly says that there is insufficient data to determine cause and effect. What it fails to say is that there is sufficient data to establish probable and possible associations which are sufficient to exercise prudent avoidance so that the potential or probable increase in risk of cancer is reduced or avoided.

Further work was reported in 1994. A subsequent draft of the EPA report, obtained by Microwave News in 1994, concluded that the EMF-cancer link "is a real association that cannot be explained by improper epidemiologic methodology". (MWN S/O 1994).

Parallel with this the ELF effects have also been reviewed by a committee of the U.S. National Council on Radiation Protection and Measurements (NCRP) (Scientific Committee 89-3: Dr Ross Adey chairman). The draft report of this committee is recommending a 2 mG (0.2 $\mu$ T), based on biophysical mechanisms derived from laboratory and animal experiments and epidemiological research which shows statistically

significant increased risk of a number of adverse health effects, including cancer. The recommended 2 mG public exposure standard for ELF is a minute fraction of the current U.K. National Radiation Protection Board (NRPB) and International Radiation Protection Association (IRPA), which is 20,000 mG.

This shows the order of the ratio necessary to protect the public from chronic epidemiologic health risk compared with acute injury risk (Shocks) from ELF's.

The research studies presented in this report justify the same order of adjustment to the RF/MW radiation exposure limits.

Microwave News (J/F 1996) reports "The Environmental Protection Agency (EPA) has indefinitely delayed the release of its already long-awaited report assessing the cancer risk of electromagnetic fields (EMFs). "The report will not come out in the foreseeable future," said Dr Robert McGaughy of the EPA's Office of Health and Environmental Assessment. McGaughy attributed part of the delay to "budgetary uncertainties" at the agency. This is despite that fact that the evidence is now even stronger than in 1989/90.

In an interview (with Dr Louis Slessin, Editor MWN), Dr McGaughy said that there are now more data supporting and EMF-cancer link than there were five to six years ago when the draft became public. Dr McGaughy cautioned that he could not predict what the report, if and when completed, would finally conclude, but stated, "I personally think that the evidence is stronger today."

Dr Doreen Hill, now working for a private company, Energetics, agreed with Dr McGaughy that the evidence for cancer risk has increased. "All the Scandinavian studies were published after 1990," she said, referring to both childhood and occupational cancer studies which showed statistically significant associations with ELF exposure.

The team leader and the lead epidemiologist from the original EPA team both stand by their original recommendations and state that the evidence is now much stronger, which suggests at least raising RF/MW non-thermal exposure to the level of Class B2 (probable carcinogen) and ELF to Class B1 (highly probable carcinogen) or even Class A (Human carcinogen).

ELF and RF/MW radiation would be classified as highly probable human carcinogens if the scientists who are charged with reviewing the research and recommending the classification were listened to. The fact that it has not happened is not a function of science, but politics and lobbying.

It is ironic that when I visited the EPA in September 1996 the researchers gave me a copy of a paper, Grayson (1996), which shows that U.S. Air Force servicemen who are exposed to RF/MW have a statistically significant increase in the incidence of brain tumour. This, after the Air Force was a strong force against adopting the EPA recommendations in 1990 and subsequently.

The tragedy is that since 1990 the public, military and industrial exposure to RF/MW (and ELF) has continued to rise, and so has the incidence of cancer. Much of the increase in cancer (and other illness) has strong links back to EMR exposure. While

no effects, not even possible effects, the situation for the public, for workers and servicemen and women continues to deteriorate.

#### **14.4 A current classification assessment:**

Several causal mechanisms are set out and well described above, including melatonin suppression, alteration of the signal transduction process at cellular level, alteration of the cell cycle at critical times such as the s-phase, co-carcinogenic effects with other carcinogens, co-promotion to enhance cancer incidence and chromosome aberrations from the action of liberated free radicals.

Long term animal experiments show statistically significantly increased benign and malignant tumours without chemical initiation, and very much enhanced incidence of lung, skin and breast tumours with chemical initiation, showing cancer initiation and promotional attributes for RF/MW radiation, consistent with the cellular changes observed in vitro.

Szmigielski's results are consistent with the re-evaluation of the U.S. Navy Korean War study, with the increase in Lymphatic and haematopoietic cancers, brain, eye and CNS, cancers, skin cancer and cancer of the respiratory and digestive organs.

Brain cancer associations were also found by Thomas et al (1987), Speers et al. (1988), Tornqvist et al. (1991) and Grayson (1996); skin cancer by Vagero et al. (1985); eye cancer by Holly et al. (1995) and leukaemia by Milham (1988), Goldsmith (1995), Dolk et al. (1997a, 1997b) and Hocking et al. (1996).

Breast cancer in women was significantly raised in Moscow, Goldsmith (1995). It is consistent with the melatonin mechanism and has been found in electrical industries, Cantor et al. (1995) and in men, Demers et al. (1991).

The Moscow Embassy staff and dependents, chronically exposed to low intensity radar signals, experienced statistically significant increases in childhood leukaemia incidence and death, Goldsmith (1995). This is consistent with Hocking et al. (1996), Maskarinec and Cooper (1993), and Anderson and Henderson (1986).

The Moscow Embassy study also involved blood tests which showed significantly elevated hematocrit and monocyte count, and lower neutrophil concentrations. White blood cells were strikingly higher, Goldsmith (1995). he also reports that the occurrence of multiple-site cancers was unusually high, 1.33 sites/person compared to 1.02 expected from the Third National Cancer Survey.

**Together these results, reinforced by animal experiments, make the strong case of classifying RF/MW radiation exposure a highly probable human carcinogen. Class B1, or even Class A, according to U.S. EPA classification.**

Exposure levels at which Risk Ratios are significantly raised average less than  $10 \mu\text{W}/\text{cm}^2$  for military and occupational studies and less than  $0.1 \mu\text{W}/\text{cm}^2$  for residential studies. For example Hocking et al.(1996) where calculated exposures of the "exposed" group residences are in the range  $0.2$  to  $2 \mu\text{W}/\text{cm}^2$  , but measured outdoor levels were around

1/5th of this, i.e. 0.04 to  $0.4\mu\text{W}/\text{cm}^2$ , but mean exposures, including indoor time, will be even lower. This is consistent with the results of Lester and Moore (1982, 1985).

#### **14.5 Mortality statistics significantly underestimate morbidity:**

The absence of specifically directed studies involving a comprehensive assessment of potential health effects probable leads to a major underestimate of the possible adverse effects. This arises because mortality statistics are more robust and more readily available than is the incidence of non-fatal tumors and lesions for example. Demers et al. (1992) demonstrate this using a Tumor Registry versus Death Certificates in an Occupational Cohort Studies in the United States. Their abstract records the following conclusion:

**"As expected, an increased ability to study relatively common cancers with low fatality rates was demonstrated by the incidence data. The most dramatic example was seen for bladder cancer. Twenty-four bladder cancers were diagnosed among the study cohort (consisting of 4,528 Tacoma fire fighters and police officers) between 1974 and 1989, whereas only two deaths were attributed to this malignancy."**

Hence most studies which are related to mortality statistics grossly underestimate the adverse health effects. Thus studies of the full potential impact of any particular environmental stressor are difficult and rare because of the limitations in available data and the complexity of human subjects. This is more likely to lead to an under-estimate of the impact of a particular stressor than an over-estimate.

Thus it is vital to remember that most epidemiological studies used to assess carcinogenicity use mortality statistics. There is between 10 and 20 times more tumours produced which do not result in death but are a major cost on the health system, extremely worrying to the person and causes loss of earnings.

### **15. Human EEG Studies:**

#### **15.1 Background:**

Several studies show disruption to human sleep and behaviour with exposure to EMR. The Schwarzenburg Study identified sleep disruption and children's performance impairment. Children's performance impairment was also found in the Skrunda and Chinese research. Sleep disruption is related to pineal melatonin which is shown to be suppressed in ELF exposure and is suggested to be suppressed by the Schwarzenburg Study. All of these studies suggest that the effects should be seen by changes to human brain activity, such as that shown by the EEG. Brains in rest states have a dominance of very low frequency waves  $f < 4\text{Hz}$ , called delta waves. In a more alert state the EEG waves become more coherent and concentrated at high frequencies, such as near 10 Hz, alpha waves.

Shandala et al. (1979) found that  $10\mu\text{W}/\text{cm}^2$  microwaves produces brain activity changes through monitoring the EEG of rabbits which include a movement away from delta waves towards alpha waves, as suggested above.

These interactions include entrainment of brain EEG rhythms at the same frequencies as the ELF components of the imposed fields, conditioned EEG responses to imposed fields, and modulation of brain and behavioural states, Bawin et al (1973); and in non-nervous tissues, strong effects on cell membrane functions, including modulation of intercellular communication through gap junctions mechanisms, Fletcher et al. (1986), reduction of cell mediated cytolytic immune responses, Lyle et al. (1983), and mediation of intracellular enzymes that are markers of signals arising at cell membranes and couple to the cell interior, Byus et al. (1984, 1988).

### **15.2 Human EEG changes after exposure to ELF-modulated microwaves:**

Von Klitzing (1995) reports changes to human brain EEG with a signal of 217 Hz modulation on a 150 MHz carrier with an SAR of 0.001 W/kg. This is equivalent to an external exposure of about  $0.7 \mu\text{W}/\text{cm}^2$  (from Eq. 8 using  $\sigma=0.77 \text{ S/m}$ ).

Von Klitzing's paper presents an example of the 45 experiments from 17 students tested. Around 70 % of the students showed significant alteration in their EEG at these very low exposure levels.

### **15.3 Cell phone signal alters sleep EEG:**

Mann and Roschke (1996) exposed 14 healthy, non-smoking, non-drinking, 21-34 year old male volunteers to 900 MHz, pulsed at 217 Hz with a pulse width of 580  $\mu\text{s}$ , digital GSM signal with a resultant average power density at the head of  $50 \mu\text{W}/\text{cm}^2$ . They concluded that

**"Besides a hypnotic effect with shortening of sleep onset latency, a REM suppressive effect with reduction of duration and percentage of REM sleep was found. Moreover, spectral analysis revealed quantitative alterations of the EEG signal during REM sleep with an increased spectral power density. Knowing the relevance of REM sleep for adequate information processing in the brain, especially concerning the mnemonic functions [Memory functions] and learning processes, the results emphasize the necessity to carry out further investigations on the action of this type of electromagnetic fields and the human organism."**

The results are summarized in Figure 29.

Reite et al. (1994) also found an hypnotic effect when a 27.12 MHz signal, modulated at 42.7 Hz as applied over a 15 min period. Exposed subjects reached a deeper state of sleep than sham exposed subjects.

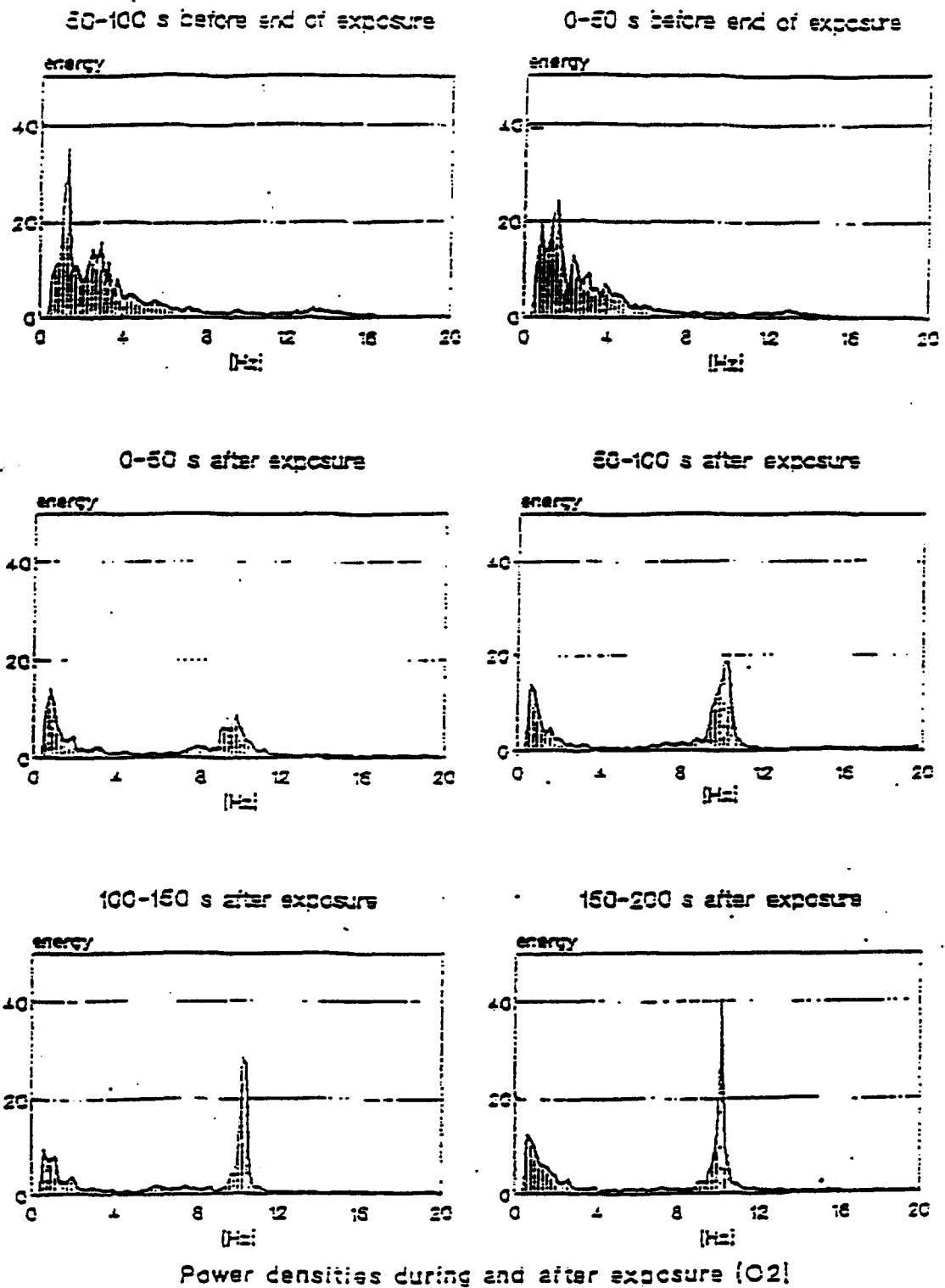


Figure 28: Alpha-EEG (O2-position) of man is altered by pulsed microwave fields, shown for periods during exposure and immediately after exposure to demonstrate prompt energy increase, von Klitzing (1995).

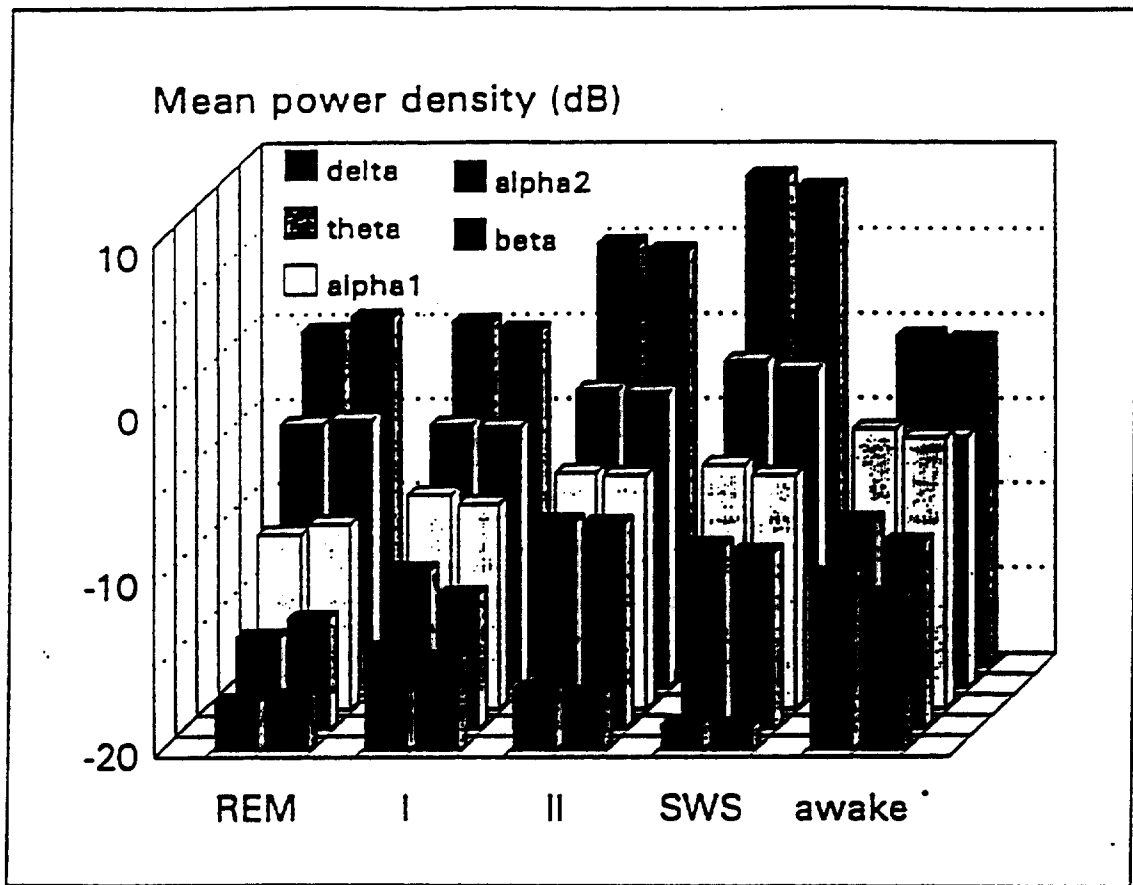


Figure 29: Mean power density (dB) of the averages of different sleep stages in 12 subjects averaged, left columns without field and right columns with GSM digital field of  $50 \mu\text{W}/\text{cm}^2$ .

#### 15.4 Conclusions - EEG and EMR:

These recent studies show unequivocal evidence that low level modulated and pulsed RF/MW signals, including GSM digital signals, alter the human EEG and affect the state of sleep in ways which interfere with information processing and learning. This confirms a neurological basis for the observed impairment of children's learning in Schwarzenberg, Latvia and China.

Hence, far from being an isolated example, as this data was considered by the Planning Tribunal, the von Klitzing results for human beings is consistent with research on people and rabbits, Dumanskiy and Shandala (1974) and Shandala et al. (1979); and in cats, Bawin et al. (1973). Studies on altered reaction times and circadian rhythms in humans and animals are linked to EEG changes, Adey (1981).

Adey (1991) goes a considerable way towards describing the mechanisms which underlie these changes in the brains of higher animals, including people. Dendritic cells in the brain, high levels of entrainment of ELF signals from RF/MW ELF modulated radiation, associated with changes in calcium ion concentrations and altered release and binding of neurohormones and neurotransmitters, such as GABA, serotonin and melatonin, have all been described and linked to EMR exposure.

Hence Dr von Klitzing's results are consistent with animal experiments, have a basis in Neurophysiology and therefore stand as a serious concern about the impact of very low intensity modulated RF/MW signals on the fundamental processing of information by our brains. The intensities of exposure which show effects are all non-thermal and reach levels well below the current public exposure standard ( $200 \mu\text{W}/\text{cm}^2$ ), at 50, about 1 and  $0.7 \mu\text{W}/\text{cm}^2$ . With isolation from natural environment's  $0.3 \text{ pW}/\text{cm}^2$  Schumann Oscillations also having measurable effects of circadian rhythms.

## 16. Conclusions

### 16.1 Faulty Methodology:

In the MacIntyre Case, the Planning Tribunal followed a faulty methodology in its approach to the evidence. It separated epidemiological studies and dismissed them individually by making some mistakes, including misclassification of evidence, inappropriate interpretation of epidemiology and incorrect attribution of opinion. Epidemiological practice looks for cross-study patterns and consistency in the group of available studies taken together, rather than adopting or dismissing individual studies. One well conducted epidemiological study which finds a statistically significant increase in risk in association with increased exposure, with all known confounders appropriately dealt with, can be sufficient justification for avoidance action to be initiated. This is strengthened when a plausible mechanism has been demonstrated through in vitro cellular processes and/or through in vivo animal experiments.

When across two or more epidemiological studies a consistent pattern of statistically significant increased risk is associated with increased exposure, then A stronger association exists. An especially strong factor exists when a dose-response relationship is also found. Statistically significant dose response relationships exist for the physiotherapists study, the Korean War Study and the Polish Military Study.

Dr Luben outlined well founded and replicated research in which RF/MW radiation changed cells in vitro in ways which could lead to cancer, through altered signal transduction and ODC activity which produced potentially neoplastic cells. Professor Goldsmith summarised a suite of epidemiological studies which showed mutations in blood cells and increased cancer incidence with increased RF/MW exposure. All of the cancer studies identified leukaemia as a high risk factor, and the adult studies found increased risks of cancer at a wide range of sites. All of these are identified by at least two and usually three or more independent studies.

### 16.2 Condition review fully justified:

Papers not presented to the Planning Tribunal for the MacIntyre Case and research which has been published since then add considerable weight to the evidence of plausible mechanisms and adverse effects at very low exposure levels. This fully justifies a review of the  $2 \mu\text{W}/\text{cm}^2$  public exposure condition, imposing a much lower acceptable level.

### 16.3 Cellular Studies:

Advances in the understanding of cellular level interactions goes beyond the research presented at the Planning Tribunal in November 1995. Resonant absorption at the cell membrane was demonstrated by Liu and Cleary (1995). A review of research on effects of microwaves on the nervous system 1990-1995, published in October 1996, states:

**"The use of weak electromagnetic fields to study the sequence and energetics of events that couple humoral stimuli from surface receptor sites to the cell interior has identified the cell membrane as a primary site of interaction with these low frequency fields in the pericellular fluid. field modulation of the cell surface chemical events indicates a major amplification of initial weak triggers associated with the binding of hormones, antibodies and neurotransmitters to their specific binding sites. Calcium plays a key role in this stimulus amplification, probably through highly cooperative alterations in binding to surface glycoproteins, with spreading waves of altered calcium binding across the membrane surface. Protein particles spanning the cell membrane form pathways for signaling and energy transfer. Fields millions of times weaker than the membrane potential of  $10^7$  V/m modulate cell responses to surface stimulating molecules.**

**The evidence supports non-linear, non-equilibrium processes at critical steps in transmembrane coupling. Cancer promoting phobol esters act at cell membranes to stimulate ornithine decarboxylase which is essential for cell growth and DNA synthesis. This response is enhanced by weak microwave fields also acting at the cell membrane. There is strong evidence that cell membranes are powerful amplifiers of weak electrochemical events in their vicinity", Vorst and Duhamel (1996).**

Microwaves, 915 MHz, whether pulsed or continuous, open the Blood-Brain Barrier, making the brain more open to toxic polar molecules and weakening the BBB changes the system which controls the stability of the fluid movement of the brain's intracellular compartment. The specific results are, Vorst and Duhamel (1996):

- 1) Exposed animals are at risk for opening the BBB (Odds Ratio =3.8,  $p=0.0004$ ).
- 2) The response is independent of pulse repetition rate, and the response is the same for CW as compared to pulsed modulation.
- 3) The response is independent of SAR in the interval  $0.016 < \text{SAR} < 2.5 \text{ W/kg}$  (Odds Ratio = 3.3), but rises for  $\text{SAR} > 2.5 \text{ W/kg}$ .

### 16.4 Cancer Studies:

It has been clearly shown here that according to international criteria, RF/MW radiation is a highly probable carcinogen. Statistically significant increases in cancer mortality incidence occurs in population exposed to significantly less than  $1 \mu\text{W}/\text{cm}^2$ . With the grouped results in Table 15, higher exposures correspond to higher risk ratios, giving a

grouped dose-response. These are more than sufficient to establish a potential adverse health effect "of low potential probability and high potential impact".

**Table 15: Summary of mean exposures to RF/MW radiation and risk ratio ranges for cancers.**

Study	Exposure Range $\mu\text{W}/\text{cm}^2$	Risk Ratio Range
Polish Military	< 1.6 - 5.6	3.0 - 13.9
Moscow Embassy	< 0.1 - 2.4	1.7 - 5.0
Korean War	?	1.9 - 3.3
North Sydney	< 0.04 - 1.6	1.61 - 2.74

This report extends the data presented to the Planning Tribunal to cover many more detailed mechanisms at the cellular level which are consistent with developing unregulated cell proliferation, cell cycle timing alteration, gap junction communication interference, damaged DNA, chromosome aberrations, melatonin disruption and impaired immune system cells.

Long term animal studies have shown increases in benign and malignant tumours (carcinomas) at a multitude of sites, consistent with the whole body coverage of EM radiation; with skin cancer, breast cancer, lung cancer, cancer of the white cells, lymphatic tumours and myeloid leukaemia, atrophy of the testes, lower birth weight, still birth, resorption, hemorrhage and stunted growth, and altered brain activity (EEG), reaction times and learning retention.

These are consistent with the Korean War Study, the Polish Military Study, the Moscow Embassy Study, the North Sydney Study, the U.S. Airforce brain cancer study, Air Force Base and cancer study, National Cancer Institute Electronics Industry Brain Cancer study, and a host of other studies linking RF/MW exposure to cancer of many kinds.

#### **16.5 Reproduction Studies:**

Studies on the adverse effects of RF and MW exposure on pregnancy involving physiotherapists, show MW to be a risk factor for early spontaneous miscarriage and RF to be a risk factor for perinatal death and congenital deformity. Mean exposure levels in the range 0.04 to 0.56  $\mu\text{W}/\text{cm}^2$ , corresponding to 10 treatments per month, is associated with an Odds Ratio of 1.50 (CI:1.04-2.17). This approach to averaging is appropriate because of the very high plausibility of a non-thermal mechanism, such as chromosome aberrations from the release of free radicals. A higher rate of damage from a given MW exposure compared with RF rate of damage, could well explain the early pregnancy effect of MW and the late pregnancy effects of RF.

#### **16.6 Biological Studies:**

Human beings are not the only part of the environment which have shown adverse biological impacts of exposure to RF/MW radiation at very low mean ambient levels.

Adverse biological effects on plants and animals have been identified in the Schwarzenburg and Skrunda Studies. Pine tree growth ring annual increments were significantly reduced at 4 km from the Skrunda radar, in mean measured exposure levels of  $0.0027\mu\text{W}/\text{cm}^2$ , a six-fold chromosome damage level in cattle blood was found in the absolute range  $0.04$  to  $6.6\mu\text{W}/\text{cm}^2$ , and mean measured exposure range  $0.16$  -  $0.63\mu\text{W}/\text{cm}^2$ , a similar range for the plants which demonstrated massive disruption of their reproductive system.

#### **16.7 Children's performance:**

Adverse effects are found at very low mean environmental levels of exposure to RF/MW which relate to performance rather than health. Children's intellectual and physical performance levels were significantly impaired in both the Swiss and Latvian studies, in mean residential exposure levels in the range  $0.03$  to  $9.06\mu\text{W}/\text{cm}^2$ , median  $0.1\mu\text{W}/\text{cm}^2$  and mean  $0.24\mu\text{W}/\text{cm}^2$  in Switzerland and  $0.003$  to  $0.04\mu\text{W}/\text{cm}^2$  in Latvia.

These results are consistent with the very significant human EEG changes observed by Von Klitzing (1995), at exposure levels of  $0.7\mu\text{W}/\text{cm}^2$ .

The Chinese study, Chiang (1988) also showed significant changes in children mental and physical performance, but at slightly higher levels of exposure,  $0-4\mu\text{W}/\text{cm}^2$ .

#### **16.8 Sleep disruption, fatigue, aches and blood pressure:**

These Swiss exposures were also associated with significant increases in reported disorders, especially in those over 45 years, involving sleep disruption and chronic fatigue syndrome, related to melatonin reduction, as well as aches, pains, lung problems and heart problems. These were associated with mean exposure levels (Zones A and B) in the range  $0.024$  -  $0.24\mu\text{W}/\text{cm}^2$ .

### **17. Review of Conditions:**

The Planning Tribunal decision A 15/96 said that "the provisions of the Act (RMA, 1991) could be invoked if it should turn out, contrary to the evidence before us, that the transmissions have an adverse effect, including the ability to review the condition". There is new evidence. There are strong ground to review the allowable public exposure limit downwards.

**This suggests setting the Public exposure limit at  $0.1\mu\text{W}/\text{cm}^2$  if cancer risk is to be reduced and  $0.01\mu\text{W}/\text{cm}^2$  if miscarriage risk, sleep disruption, children's performance impairment and chronic fatigue symptoms are to be reduced.**

These levels relate to disruption of the fine biological balances of biochemical and bioelectrical systems in human bodies and not to gross thermal stress, as the present standards do. The evidence that cancer risk unequivocal, as are stress levels in populations in relation to chronic low-level exposure to RF/MW radiation. Research strongly implicates electromagnetic radiation in the rising rates of environmentally sourced

cancer in New Zealand and around the world. Ambient RF/MW exposures have risen from around  $10\text{pW}/\text{cm}^2$  prior to the invention of radio, TV and radar, to around  $0.0001\text{--}0.0005\mu\text{W}/\text{cm}^2$  in rural New Zealand today, a rise of a factor of 10 to 50. In New Zealand cities the levels are typically at least 10 times higher. The limits recommended here to protect public health and well-being, allow a further rise from rural exposures of a factor of 20 to 100 for the well-being limit and 200 to 1000 for the public health limit.

However, despite these massive allowances the recommended limits place severe limits on the locations of transmission facilities in the vicinity of dwellings and other location where people spend a large amount of time.

In time these limits might need to be revised downwards, but they would be a major step forward in the protection of public health, and would allow industry a chance to reduce their public exposing emissions through the adoption of buffer zones in the short-term, protecting both the public health and the industrial investment, and the move to low or no emission communication technologies such as direct satellite links (low emission) and fiber optic cables (no emission).

In the mean time this should require the placement of telecommunication transmission sites (radio, TV, cell sites) some considerable distance from residences, schools, kindergartens, hospitals, etc. so that their background RF/MW exposure levels are not raised by more than a factor of 10 to 50. This can be legally enforced through the application of sections 3 and 5 of the Resource Management Act 1991 and should be applied to all resource consents. New Resource Consents should have these limits applied and existing consents should have their conditions reviewed and the new conditions applied as soon as is possible and practicable.

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